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Family medicine physician teachers and residents' intentions to prescribe and interpret spirometry: a descriptive cross-sectional study

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ABSTRACT

Background: Spirometry is the best test to demonstrate airway obstruction, but remains underused in primary care. **Objectives:** We assessed, among family medicine physician teachers and residents, their intention to prescribe spirometry in patients suspected of chronic obstructive pulmonary disease and their intention to interpret the results. This evaluation is based on the theoretical framework proposed by Godin et al. for the study of factors influencing healthcare professionals' behavior. **Methods:** Participants of this descriptive cross-sectional study were recruited from eight Family medicine units (FMUs) of Laval University's network. They completed a 23-item self-administered questionnaire measuring their intention to prescribe and to interpret spirometry as well as some determinants of this intention (beliefs about capabilities, beliefs about consequences, social influence and moral norm). Answers to each of the items were scored on a Likert scale (score 1 to 7) where a higher score indicated a greater agreement with the statement. **Results:** Of the 284 eligible physicians, 104 were included. The mean score $\pm$ standard deviation of physicians' intention to prescribe spirometry (6.6 ± 0.7) was higher than to interpret the results (5.8 ± 1.5). Mean scores for all determinants of intention measured were also higher for prescription than for interpretation of spirometry. **Conclusion:** The results suggest that participants have a very strong intention to prescribe spirometry. Although the intention to interpret the results is positive, it is weaker than for the prescription of the test. Further studies will be needed to assess the barriers to spirometry interpretation.

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Introduction

Chronic obstructive pulmonary disease (COPD) is caused by exposure to noxious particles or gases, (the major risk factor being tobacco smoking) [1]. This exposure leads to airway damage and/or alveolar abnormalities, a mixture of small airways disease and parenchymal destruction that causes airflow limitation and persistent respiratory symptoms [1]. Unfortunately, COPD is often confounded with other chronic medical conditions, increasing morbidity and mortality of patients [1]. It is one of the most deadly chronic pulmonary diseases, being the cause of death of 3 million of people worldwide in 2012 [2] and the fourth leading cause of death in Canada [3]. Furthermore, its prevalence is increasing in Canada [4]. According to the Report from the Canadian Chronic Disease Surveillance System (CCDSS), among

all Canadians aged 35 years and over, the relative increase in the age-standardized prevalence of COPD was 33.6% between 2000–2001 and 2011–2012 [4]. This represented an increase from 7.0% (1.1 million) to 9.4% (2.0 million) of Canadians [4]. This relative increase was much more significant among females (42.8%) than among males (22.9%), although males still consistently had a higher prevalence [4]. Those differences could be attributed to the latency period between smoking and COPD, the smoking rates being historically higher among males [5]. This, in addition to the aging of the population, could also explain why COPD is increasing globally despite a decrease in smoking prevalence [4,5]. COPD prevalence is also different across Canada [4]. The global age-standardized prevalence of diagnosed COPD was

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9.4% in Canada in 2011–2012, which is similar to the prevalence of Quebec (9.0%) [4].

According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD), spirometry is the gold standard for the diagnosis and management of COPD, even if clinical history, physical examination and symptoms suggest such diagnosis [1]. From a forced expiratory maneuver, spirometry can assess the forced vital capacity (FVC), the forced expiratory volume in 1 second (FEV₁), and their ratio, a measure of airway obstruction [1]. Not only does it allow to demonstrate airflow limitation and to assess the severity of chronic respiratory diseases, but it can also help evaluate the efficacy of treatments [1,6]. As stated by the Canadian Thoracic Society (CTS), “patients who are older than 40 years of age and who are current or ex-smokers should undertake spirometry if they answer yes to any one of the following questions: 1. Do you cough regularly? 2. Do you cough up phlegm regularly? 3. Do even simple chores make you short of breath? 4. Do you wheeze when you exert yourself, or at night? 5. Do you get frequent colds that persist longer than those of other people you know? [7]. Similarly, the American College of Physicians (ACP), the American College of Chest Physicians (ACCP), the American Thoracic Society (ATS) and the European Respiratory Society (ERS) recommend the use of spirometry for the assessment of airway obstruction in patients with respiratory symptoms [8].

Unfortunately, several studies have reported an inconsistent and low use of spirometry in primary care as a diagnostic and follow-up tool in COPD [9–13]. For example, in a cross-sectional study conducted in Hong Kong to observe which investigations COPD patients actually receive, only 18.3% of them had a spirometry at the time of diagnosis [12]. A Canadian study assessing first-line practices in patients with COPD in Quebec and Ontario versus recommended care found that only 56% of the 1090 patients included had a diagnosis confirmed by spirometry [13]. In Spain, the use of spirometry was also different between rural and urban primary care centers, as shown by a cross-sectional study conducted in 2012 by telephone survey [14].

One of the major impacts of underuse of spirometry is undoubtedly the underdiagnosis of COPD [4,15,16]. This underdiagnosis is particularly a source of concerns resulting in untreated symptoms and recurring exacerbations that could have been otherwise prevented, and an increased number of emergency department visits and hospitalizations [16]. This is also supported by a recent report from the CCDSS

which suggests that the burden of this disease might be higher than what they present in their report because of spirometry underuse [4]. Conversely, the underuse of spirometry can also lead to COPD misdiagnosis and overdiagnosis [17], which also contributes to healthcare burden [18]. A broader use of spirometry could help reduce the societal burden of COPD by an early detection of the disease resulting in earlier treatment [4]. This could lead to better health outcomes and better quality of life for Canadians living with COPD [4].

Several barriers to prescription of spirometry by family medicine physicians have been identified, including: limited access to spirometry [19], not considering spirometry as a diagnostic tool [19], lack of comfort with interpretation of spirometry [19], and the belief that COPD can only be diagnosed clinically [13,20]. Furthermore, the existence of many decision algorithms on the diagnosis of COPD from spirometric criteria can lead physicians to different conclusions, making interpretation of spirometry difficult [21–23]. In addition, criteria for the validity of the spirometry curve [24] and spirometer calibration [25] complicate the process of interpreting spirometry results.

To the best of our knowledge, no study based on a theoretical framework, that is, on factors that are known to predict clinical behavior [26,27], has evaluated the intention of teachers and residents to prescribe spirometry and to interpret its results. The framework for the study of healthcare professionals’ behavior and intention by Godin et al., which is based on the results from a systematic review, could be useful to predict health professionals’ clinical behavior [26]. To our knowledge, this is the first study to use the CPD-Reaction questionnaire to measure intention to prescribe and interpret spirometry.

As shown in Figure 1, seven constructs drive the intention of healthcare professionals to do a professional behavior: (1) beliefs about capabilities; (2) habit/past behavior (the frequency of performing the behavior in the past) [26]; (3) beliefs about consequences; (4) social influences; (5) moral norm; (6) role and identity (beliefs about whether such behavior should be adopted by someone of similar age, sex or social position) [27]; (7) characteristics of health professionals based on their socio-demographic data [26]. The targeted behavior can be directly predicted by the analysis of three major constructs: the “intention” itself, the “beliefs about capabilities” and the “habit/past behavior,” which are all directly influencing the behavior (Figure 1).

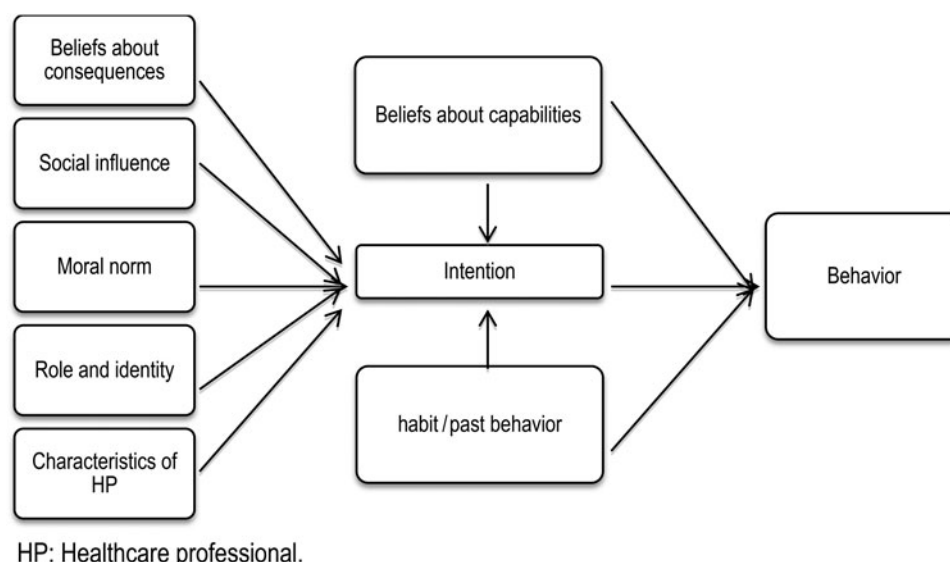


Figure 1. Hypothesized theoretical framework for the study of healthcare professionals' behavior and intention, adapted from Godin et al. [26].

The primary objective was to assess, among family medicine physician teachers and residents from the network of FMUs of Laval University, their intention to prescribe spirometry in patients suspected of COPD and their intention to interpret the results. This evaluation was based on the theoretical framework proposed by Godin et al. for the study of factors influencing the behavior of healthcare. The secondary objectives were to compare the results according to the location of the FMUs (urban vs. rural), the status (teacher vs. resident) and the gender (male vs. female) of the physicians. Better understanding of the factors that predict the use of spirometry are important for the development of effective interventions to enhance the use of spirometry in primary care practice.

Methods

Study design and setting

This was a descriptive cross-sectional study conducted in eight FMUs affiliated with Laval University, Quebec City, Canada. This study was done in the context of a research program on the development of electronic tools to support interpretation of spirometry (Clinical trials number: NCT03206) (unpublished data). In the trial, we aimed to assess the impact of an interactive mobile application (SPIRO©) to facilitate the prescription and interpretation of this test by family medicine physician teachers and residents. The present study is an analysis of the results of the questionnaires completed before the use of the application.

Participants and recruitment strategies

Participants were recruited from October 2016 to July 2017. Eligible participants were family medicine physician teachers or residents working in eight of the 12 FMUs affiliated with Laval University who accepted to participate in the study. All participants signed an informed consent form. The study was approved by the ethics committee of the *Centre de santé et services sociaux (CSSS) de la Vieille-Capitale – associated to the Centre intégré universitaire de santé et de services sociaux (CIUSSS) de la Capitale-Nationale* (approval number: 2016–2017-01 MP).

Recruitment of participants

When possible, the study coordinator (A.D.) presented the project to teachers and residents during an on-site meeting and invited them to participate to the study. Otherwise, she sent an email to a resource person in each FMU (teacher or administrative technician) to present the study. She then sent the study presentation letter, informed consent forms, and questionnaires to the FMU, which were dropped in each of the teachers' and residents' letterbox by the resource person of the FMU. Participants were asked to provide written informed consent and complete the self-administered questionnaire (see section "Variables"). Participants sent back the questionnaires to the study coordinator using addressed and stamped envelopes. Two reminders were sent. All study material was in French.

Measured variables

Intentions, social influence, beliefs about capabilities, moral norm and beliefs about consequences regarding intention to (1) prescribe and (2) interpret spirometry were assessed using a questionnaire adapted from a previously validated instrument, the Continuing Professional Development (CPD)-Reaction questionnaire which is based on the framework for the study of healthcare professionals' behavior and intention proposed by Godin et al. [26]

The original 12-item CPD-Reaction questionnaire is a reliable, valid [27,28] and responsive [29] generic instrument that was developed to assess the impact of CPD activities on health professionals' clinical behavioral intentions [27–30]. The CPD-Reaction questionnaire assesses intentions, social influence, beliefs about capabilities, moral norm and beliefs about consequences regarding making a change in CPD participants' clinical behavioral described as a specific objective of the education activity. The questionnaire thus needed to be adapted to the targeted behavior. Items were scored on a Likert bipolar scale ranging from 1 to 7 (e.g. Strongly disagree = 1, Strongly agree = 7). For each construct, scores are averaged (a higher score indicated a greater agreement with the statement).

One item pertaining to moral norm (i.e. It is ethical to interpret spirometry to this patient in a context of COPD screening) was withdrawn regarding interpretation of spirometry results, as the investigators considered the answer to be too obvious. To adapt the CPD-Reaction questionnaire regarding (1) prescription and (2) interpretation of spirometry, our research team inserted the behaviors into each item of the CPD-Reaction questionnaire and added the context of COPD diagnosis. It is important to note that the research team also adapted the CPD-Reaction questionnaire by using a clinical scenario that participants had to consider when answering the question (for details, please see Online supplement). This scenario corresponded to the description proposed by the CTS of which patient should undertake spirometry [7]. The final 12-item (prescription) and 11-item (interpretation) questionnaires are available as an online supplement.

To ensure face validity of the adapted version of the CPD-Reaction questionnaire, six teachers and one resident commented on whether or not the items were understandable, the number of questions was adequate, and the time required to complete the questionnaire was reasonable. Minor changes were made based on the feedback provided. The internal consistency of the final adapted version the CPD-Reaction

questionnaire was calculated from data collected during the present study. Cronbach's alpha coefficients ranged between 0.81 and 0.84 for social influence, beliefs about capabilities, moral norm and beliefs about consequence and it was 0.62 for intention regarding prescription of spirometry. In regards to interpretation of spirometry, the coefficients ranged between 0.70 and 0.96 for all constructs. Items were scored on a Likert bipolar scale ranging from 1 to 7 (e.g. Strongly disagree = 1, Strongly agree = 7). For each construct, scores were averaged (a high score was better). The final 23-item questionnaire is available in online supplement.

Characteristics of participants

According to the Laval University Faculty of Medicine classification (please refer to: <http://www.fmed.ulaval.ca/>), four FMUs were classified as urban and four FMUs as rural. Sociodemographic variables (gender, age, professional status, and number of years of practice, if applicable) were collected by self-completed questionnaire.

Statistical analysis

Characteristics of patients were expressed using mean $\pm$ SD or percentage. Comparisons between the practice locations, genders as well as between teachers and residents were performed using the Fisher's exact test for nominal variables and one-way ANOVA with heterogeneous variance between levels for continuous variables. The differences between scores of the constructs (intention, social influence, beliefs about capabilities, moral norm, and beliefs about consequences) for urban vs. rural FMUs and teachers vs. residents were considered clinically significant if the mean difference between scores was ≥ 0.5 on the Likert scale [31]. Differences were considered statistically significant at a p -values of ≤ 0.05 . All analyses were conducted using the statistical package SAS, version 9.4 (SAS Institute Inc, Cary, NC, USA).

Availability of data

The data are available on demand.

Results

Participants' characteristics

Out of 284 eligible participants, 112 agreed to participate to the study (response rate = 39%). Of this number, 8 were excluded because of an incomplete

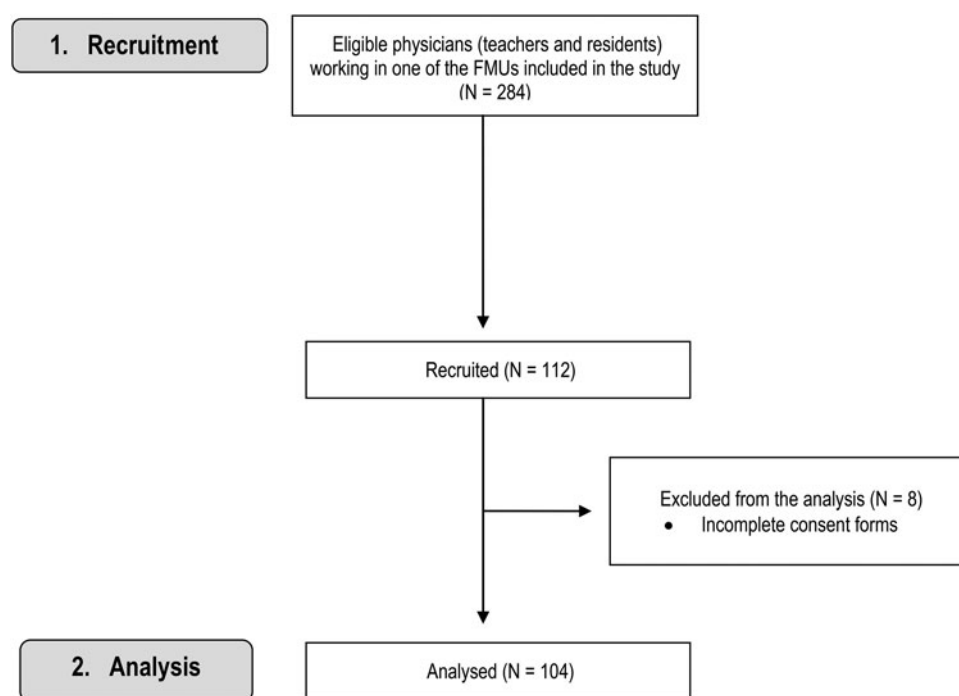


Figure 2. Recruitment flow chart.

consent form (Figure 2). The majority of the 104 participants included were family medicine physician teachers (62%), women (67%) and aged between 25 and 44 years (74%) (Table 1). There was no statistical difference between participants' characteristics according to FMU (rural vs. urban) and status (teacher vs. resident), except for age (Table 1). There was a significant difference in the number of years of practice of males and females (Table 1).

Intention to prescribe spirometry

Table 2 summarizes the mean scores of intention to prescribe spirometry for the diagnosis of COPD and four of its determinants: social influence, beliefs about capabilities, moral norm and beliefs about consequences according to the location of the FMUs (urban vs. rural), the status of the physicians (teachers vs. resident) and the gender (male vs. female). Figure 3 illustrates the mean scores of the five constructs presented in the theoretical framework for the study of healthcare professionals' behavior and intention, adapted from Godin et al. [26] regarding "prescription" of spirometry.

The mean score on the 7-point Likert scale for total FMUs was positive (i.e. >4 , the neutral point) and close to 7 for all constructs except for the social influence (6.0 ± 1.1) (Table 2). For the prescription, there were no significant differences between rural vs. urban

FMUs, teachers vs. residents, and between males vs. females (Table 2).

Intention to interpret spirometry

Table 3 summarizes the mean scores of the intention to interpret spirometry results for the diagnosis of COPD and four of its determinants: social influence, beliefs about capabilities, moral norm and beliefs about consequences according to the location of the FMUs (urban vs. rural), the status of the physician (teacher vs. resident) and the gender (male vs. female) (Table 3).

The mean scores were positive for all constructs, but were below 6 for intention, social influence and beliefs about capabilities, compared to prescription (Table 3). Participants from rural FMUs had a significantly higher intention to interpret spirometry than the urban participants. The mean score of social influence regarding the interpretation of spirometry was significantly higher in the rural FMUs. Participants from rural FMUs had a significantly higher belief in their capacity to interpret a spirometry result than their urban colleagues. Moreover, the mean score for moral norm was significantly higher for rural FMUs. For the interpretation, there were no significant differences according to the status of the physicians (teacher vs. resident) (Table 3). The comparison between men and women revealed that men were more confident about their capabilities to interpret

Table 1. Characteristics of participants.

	FMUs total <i>n</i> (%)	Urban FMUs <i>n</i> (%)	Rural FMUs <i>n</i> (%)	<i>p</i> -value ^a –	Teachers <i>n</i> (%)	Residents <i>n</i> (%)	<i>p</i> -value ^b –	Males <i>n</i> (%)	Females <i>n</i> (%)	<i>p</i> -value ^c –
Number of participants	104 (100)	53	51	–	64	40	–	34	70	–
Sex										
Male	34 (33)	15 (28)	19 (37)	0.40	18 (28)	16 (40)	0.28	–	–	–
Female	70 (67)	38 (72)	32 (62)		46 (72)	24 (60)				
Age (years)										
< 25	6 (6)	6 (11)	0 (0)	0.04	0 (0)	6 (15)	<0.01	1 (3)	5 (7)	
25–34	38 (37)	22 (42)	16 (31)		10 (16)	28 (70)		12 (35)	26 (37)	
35–44	38 (37)	12 (23)	26 (51)		33 (52)	5 (13)		10 (29)	28 (40)	0.66
45–54	10 (10)	4 (8)	6 (12)		9 (14)	1 (3)		5 (15)	5 (7)	
≥ 55	12 (12)	9 (17)	3 (6)		12 (19)	0 (0)		6 (18)	6 (9)	
Status										
Teachers	64 (62)	28 (53)	36 (71)	0.07	–	–	–	18 (53)	46 (66)	0.28
Residents	40 (39)	25 (47)	15 (29)		–	–		16 (47)	24 (34)	
Number of years of practice										
< 5	13 (20)	5 (18)	8 (22)	0.15	13 (20)	–	–	1 (6)	12 (26)	
5–9	13 (20)	5 (18)	8 (22)		13 (20)	–		3 (17)	10 (22)	
10–14	12 (19)	5 (18)	7 (19)		12 (19)	–		2 (11)	10 (22)	0.03
15–19	10 (16)	3 (11)	7 (19)		10 (16)	–		5 (28)	5 (11)	
20–29	7 (11)	2 (7)	5 (14)		7 (11)	–		1 (6)	6 (13)	
≥ 30	9 (14)	8 (29)	1 (3)		9 (14)	–		6 (33)	3 (7)	

FMUs: Family medicine units.

^a*p*-value between urban and rural FMUs.^b*p*-value between teachers and residents.^c*p*-value between males and females.**Table 2.** Mean intention score of intention and of its determinants to PRESCRIBE spirometry to patients suspected to have a COPD according to FMU location, professional status of the physicians and their gender.

Construct	Total FMUs mean (SD) ^d	Urban FMUs mean (SD) ^d	Rural FMUs mean (SD) ^d	<i>p</i> -value ^a –	Teachers mean (SD) ^d	Residents mean (SD) ^d	<i>p</i> -value ^b –	Males mean (SD) ^d	Females mean (SD) ^d	<i>p</i> -value ^c –
Intention	6.6 (0.7)	6.5 (0.7)	6.7 (0.6)	0.10	6.7 (0.7)	6.4 (0.7)	0.02	6.5 (0.7)	6.6 (0.7)	0.57
Social influence	6.0 (1.1)	5.9 (1.0)	6.1 (1.2)	0.56	6.2 (0.8)	6.0 (0.8)	0.11	6.1 (0.7)	6.2 (0.8)	0.61
Beliefs about capabilities	6.6 (0.6)	6.5 (0.6)	6.7 (0.6)	0.05	6.8 (0.4)	6.4 (0.7)	<0.01	6.6 (0.7)	6.7 (0.6)	0.49
Moral norm	6.8 (0.4)	6.7 (0.5)	6.9 (0.4)	0.13	6.9 (0.3)	6.6 (0.5)	<0.01	6.8 (0.4)	6.8 (0.4)	0.70
Beliefs about consequences	6.7 (0.6)	6.5 (0.6)	6.8 (0.5)	0.03	6.7 (0.5)	6.5 (0.6)	0.05	6.7 (0.6)	6.7 (0.5)	0.92

FMUs: Family medicine units; SD: Standard Deviation.

^a*p*-value between urban and rural FMUs.^b*p*-value between teachers and residents.^c*p*-value between males and females.^dConstruct means were calculated as the average of their item scores (possible range scale 1 to 7).

spirometry than women. Figure 4 shows the mean scores of the five constructs presented in the theoretical framework for the study of healthcare professionals' behavior and intention, adapted from Godin et al. [26] regarding "interpretation" of spirometry.

Discussion

Key results

Spirometry is the gold standard to demonstrate airway obstruction in patients with COPD, but remains underused in primary care. This remains a major care gap in respiratory care. This descriptive cross-sectional study suggested that although the intention of family medicine physician teachers and residents to prescribe spirometry was positive, their intention to interpret it was weaker, as assessed using an adapted version of the CPD-Reaction questionnaire. The scores for the intention, the social influence, the beliefs about capabilities and the moral norm regarding interpretation

of spirometry were significantly higher for rural than for urban FMUs. Men had a stronger belief in their capacity to interpret spirometry than women.

Even if the mean scores for all constructs were positive, the score for interpretation was lower than for prescription. The difficulties with spirometry interpretation mentioned previously [21–23], the absence of a tool to help healthcare professionals with the interpretation of spirometry testing, the lack of interpretation skills improvement over the decades [32] and an unmet training need within primary care in the interpretation of spirometry results [32], could explain this result. Further qualitative and quantitative studies will be needed to explore what are the barriers to spirometry interpretation.

In the last decades, practice guidelines have been developed in various domains to optimize care, but unfortunately, their recommendations are insufficiently implemented [33–38]. As already mentioned, the Canadian Thoracic Society (CTS) [39], the American College of Physicians (ACP), the American

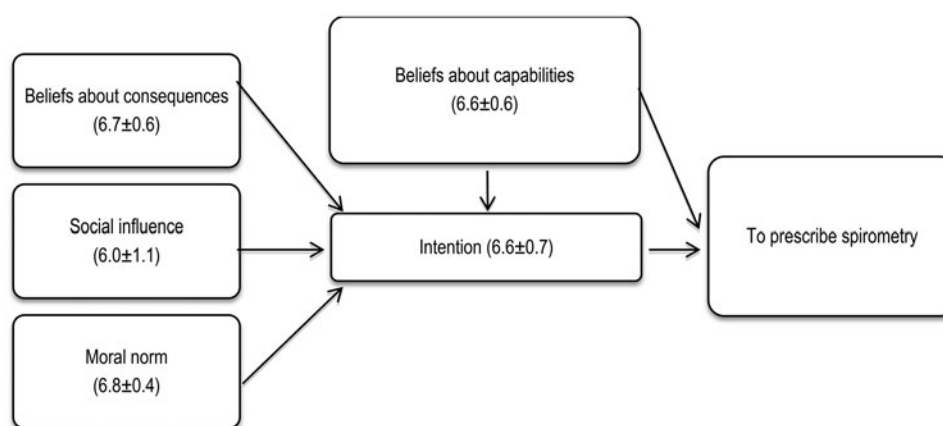


Figure 3. Mean scores of five constructs of the hypothesized theoretical framework for the study of healthcare professionals' behavior and intention, adapted from Godin et al. [26] regarding PRESCRIPTION of spirometry.

Table 3. Mean intention score of intention and of its determinants to INTERPRET spirometry to patients suspected to have a COPD according to FMU location, professional status of the physicians and their gender.

Construct	Total FMUs mean (SD)	Urban FMUs mean (SD) ^d	Rural FMUs mean (SD) ^d	<i>p</i> -value ^a –	Teachers mean (SD)	Residents mean (SD) ^d	<i>p</i> -value ^b –	Males mean (SD)	Females mean (SD) ^d	<i>p</i> -value ^c –
Intention	5.8 (1.5)	5.0 (1.7)	6.5 (0.7)	<0.01	5.8 (1.6)	5.7 (1.3)	0.78	5.9 (1.4)	5.7 (1.5)	0.57
Social influence	5.5 (1.1)	5.1 (1.3)	6.0 (0.7)	<0.01	5.4 (1.2)	5.7 (1.1)	0.24	5.7 (1.2)	5.5 (1.1)	0.46
Beliefs about capabilities	5.1 (1.4)	4.5 (1.5)	5.6 (0.9)	<0.01	5.1 (1.4)	5.0 (1.2)	0.53	5.5 (1.2)	4.9 (1.4)	0.03
Moral norm ^e	6.5 (0.9) ^e	6.2 (1.0) ^e	6.7 (0.6) ^e	0.01	6.6 (0.7) ^e	6.3 (1.0) ^e	0.10	6.5 (0.9) ^e	6.5 (0.9) ^e	0.96
Beliefs about consequences	6.5 (0.7)	6.3 (0.8)	6.7 (0.6)	<0.01	6.6 (0.6)	6.3 (0.9)	0.06	6.4 (0.8)	6.5 (0.7)	0.49

FMUs: Family medicine units; SD: Standard Deviation.

^a*p*-value between urban and rural FMUs.

^b*p*-value between teachers and residents.

^c*p*-value between males and females.

^dConstruct means were calculated as the average of their item scores (possible range scale 1 to 7).

^eBecause this construct contained only one item for the behavior "interpretation", the result is the score for the item and not a mean.

College of Chest Physicians (ACCP), the American Thoracic Society (ATS) and the European Respiratory Society (ERS) recommend the use of spirometry for the assessment of airway obstruction in patients with respiratory symptoms [8]. In a Canadian study that assessed primary care practices in patients with COPD in Quebec and Ontario versus recommended care, the authors found that only 56% of the patients included in the study had a diagnosis confirmed by spirometry [13]. The difficulties concerning the implementation of key guidelines recommendations among primary care settings could be a barrier to interpretation of spirometry. Boulet and colleagues used the Physicians' Practice Assessment Questionnaire (PPAQ) to determine what was the percentage of patients in whom physicians estimate that they implement guidelines key recommendations [40]. General practitioners reported that they confirm the diagnosis of COPD with pulmonary function tests (i.e. spirometry after bronchodilator with or without lung volumes) in about 70% of their patients suspected to have a COPD [40]. This suggests a need to better implement

guidelines. Indeed, theoretically, 100% of COPD patients should have a spirometry testing to confirm the diagnosis. It will be interesting to further assess qualitatively and quantitatively what are the barriers to guidelines implementation, precisely interpretation of spirometry.

The results showed that physicians from rural FMUs had a higher intention, felt a higher social influence, had a better belief about their capabilities and had a higher sense of moral norm regarding interpretation of spirometry testing than those from urban FMUs. As discussed by Pong and Pitblado, there are geographic distribution imbalances in the medical workforce [41]. In the rural areas, access to specialists is limited and family medicine physicians have to learn to perform certain tasks that typically would have been performed by specialists to fill gaps in services [41]. Consequently, it is legitimate to think that rural family medicine physician teachers and residents may have developed more abilities in interpreting spirometry. Unfortunately, the shortage of medical workforce in rural areas constitutes a global

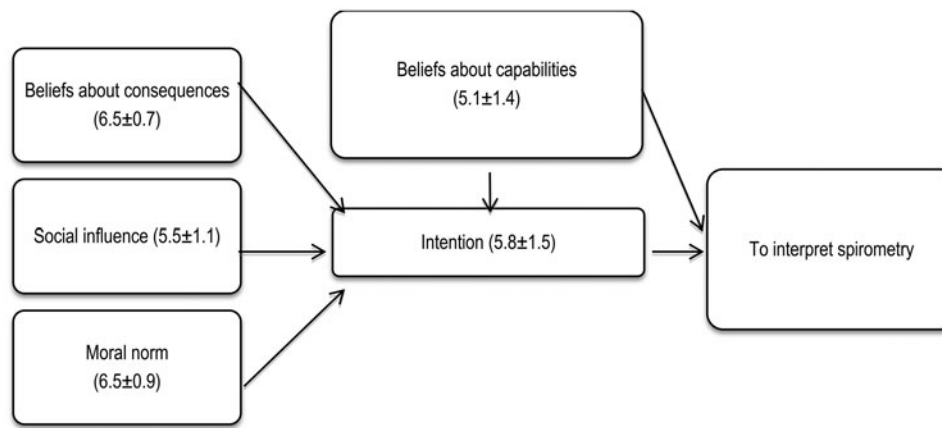


Figure 4. Mean scores of five constructs of the hypothesized theoretical framework for the study of healthcare professionals' behavior and intention, adapted from Godin et al. [26] regarding INTERPRETATION of spirometry.

long-standing problem affecting many different specialties and, at a higher level, health systems [41–45]. Furthermore, as they seem to feel more pressure (moral norm) or social influence from their peers as shown by a higher score for the constructs moral norm and social influence, they could be more motivated to improve their skills in interpretation, which can ultimately lead to a better perception of control, or better beliefs about their capabilities. Further studies are required to identify the reasons why family medicine physicians from urban FMUs feel less social influence and have less moral norm than those from rural FMUs.

Furthermore, even if the intention, the social influence, the beliefs about capabilities, the moral norm and the beliefs about consequences were positive both for prescription and interpretation, the mean scores for the interpretation were lower than for the prescription. Precisely, it suggests the possibility to particularly improve the *beliefs of physicians' capabilities* to interpret spirometry. Indeed, this construct had the lower score and it directly influences the behavior. The reasons for the lower scores for interpretation are possibly an insufficient training in spirometry interpretation in the medical school and during residency in addition to a lack of continuing medical education initiatives in this domain, as previously reported in other countries [46,47]. Discrepancies in decisional algorithms can also lead the user to different diagnostic conclusions [21–23] and can constitute another barrier to spirometry interpretation. There is a need to have access to a tool that would facilitate interpretation of spirometry among healthcare professionals.

Finally, the comparison between men and women revealed that men were more confident about their capabilities to interpret spirometry than women. Although more than 30% of men had ≥ 30 years of

experience against 7% for women, it is not clear that experience is related to intention. Indeed, if it were the case, the results would probably have shown differences between the intention of teachers and residents (who do not practice yet). Further studies are needed to determine the factors related to gender that influence confidence in spirometry interpretation.

To overcome this lack of confidence in interpretation, there is a need for teachers and residents to have access to specific training, mentoring or access to a practice aid (e.g. electronic app), to help them with spirometry interpretation. As medical students [48] and family medicine physicians increasingly use mobile devices during daily practice [48,49], an interactive mobile application could be a possible new way to promote spirometry.

Strengths and limitations

To the best of our knowledge, it is the first study based on a theoretical model that evaluated the perception of family medicine physicians regarding prescription and interpretation of spirometry. It is also the first study to specifically include family medicine physician residents, so that it can help to better understand the perception of individuals at an earlier stage of their medical career.

One of the limitations of this quantitative study is the absence of qualitative data to explain the respondents' answers. It would be interesting to evaluate precisely the barriers experienced mostly about the interpretation of spirometry testing. Currently, only hypotheses can be made to explain the reasons why these results were observed and further evaluation is needed.

There are different measures of behavior: objective (review of records) and subjective (questionnaires).

Although neither is perfect, the best way to measure behavior adoption is probably to measure the behavior itself. When this is not possible, it is necessary to find an alternative approach. Systematic reviews have concluded that intention is a valid indirect measure of clinician behavior [26,50]. In other words, there would be a predictable relationship between the intentions of a health professional and his or her subsequent behavior. In this study, it would have been more appropriate to conduct a file review to see if teachers and residents prescribe and interpret spirometry. Unfortunately, this approach was not possible due to limited resources and we considered the measure of intention as acceptable in the context our study.

Another limitation of this study is the fact that one of the constructs included in the framework for the study of healthcare professionals' behavior and intention by Godin et al. [26] was omitted, which is "role and identity." This construct evaluates the beliefs about whether such behavior (in this case prescription and interpretation of spirometry testing) should be adopted by someone of similar age, sex or social position [27]. Nevertheless, information about moral norm and social influence, which are associated to role and identity, were included in the adapted version of the CPD-Reaction questionnaire.

The fact that we used the description proposed by the CTS to target which patient should undertake spirometry for our adaptation of the generic CPD-Reaction questionnaire may have generated overly positive results. This broad clinical scenario could have been narrowed to more specific clinical vignettes. However, as the clinical scenario of both prescription and interpretation questionnaires was similar, comparison of the intention scores and of its determinants remains valid.

The questionnaire also referred to a "context of COPD screening" while we should have mentioned "in a context of suspected COPD" or "for the diagnosis of COPD." Even if this wording did not get attention of the physicians who participated to the face validity evaluation of the questionnaire, it could have been confusing for some participants. Indeed, the US Preventive Services Task Force does not recommend COPD screening [51].

Generalizability

We believe that the results of this study can be generalized to most primary care physicians. It is however possible that the intention scores to prescribe and interpret spirometry of physicians from nonacademic

health centers could be lower, as they could be less aware of the latest guidelines.

Conclusion

Our study shows that family medicine physicians have a very strong intention to prescribe spirometry. Their intention to interpret the results, although positive, is somewhat lower. Interventions designed to increase the use of spirometry in primary care could target physicians' beliefs about their capabilities to interpret the test.

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Contributions

Substantial contributions to the conception or design of the work; or the acquisition of the work; or the analysis, or interpretation of data for the work: A. D.; M.-È. B.; M. G.; M. S.; L.-P. B. Drafting the work: A. D. Revising the work critically for important intellectual content: A. D.; M.-È. B.; M. G.; M. S.; L.-P. B. Final approval of the version to be published: A. D.; M.-È. B.; M. G.; M. S.; L.-P. B. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: A. D.; M.-È. B.; M. G.; L.-P. B.; M. S.

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Adapted version of the CPD-Reaction Questionnaire (Note: A French version of the questionnaire was used during the study and during the face validity.)

Section B: Prescription of spirometry testing

Please answer each of the following questions by indicating the number that best corresponds to your opinion regarding the spirometry test prescription. Some questions may seem similar, but they measure different aspects of the stated behavior.

In order to lighten this questionnaire, the masculine will be used in its generic sense.

In a patient of 40 years or older, smoker or ex-smoker, who has no diagnosis of chronic respiratory disease

- who has wheezing during effort or during the night AND/OR
- who expects or spits regularly AND/OR
- who is out of breath, even slightly, when performing simple tasks AND/OR
- who often gets colds that persist longer than people around him AND/OR
- who coughs regularly:

	Strongly disagree							Strongly agree
B1.	I intend to prescribe a spirometry test to this patient in a context of COPD screening.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐

B2. To the best of my knowledge, the proportion of my colleagues who would prescribe a spirometry test to this patient in a context of COPD is:

0-20%	21-40%	41-60%	61-80%	81-100%
☐	☐	☐	☐	☐

[illegible][illegible][illegible]

ID Participant : _____

B6. Now think about a co-worker whom you respect as a professional. In your opinion, would he prescribe a spirometry test for this patient in a context of COPD screening?	Never						Always
	1	2	3	4	5	6	7
	☐	☐	☐	☐	☐	☐	☐
B7. I plan to prescribe a spirometry test to this patient in a context of COPD screening.	Strongly disagree						Strongly agree
	1	2	3	4	5	6	7
	☐	☐	☐	☐	☐	☐	☐
B8. Overall, I think that for me, prescribing a spirometry test to this patient in a context of COPD screening would be:	Useless						Usefull
	1	2	3	4	5	6	7
	☐	☐	☐	☐	☐	☐	☐
B9. Most people who are important to me in my profession would prescribe a spirometry test to this patient in a context of COPD screening.	Strongly disagree						Strongly agree
	1	2	3	4	5	6	7
	☐	☐	☐	☐	☐	☐	☐
B10. It is acceptable to prescribe a spirometry test to this patient in a context of COPD screening.	Totally disagree						Totally agree
	1	2	3	4	5	6	7
	☐	☐	☐	☐	☐	☐	☐
B11. I have the ability to prescribe a spirometry test to this patient in a context of COPD screening.	Strongly disagree						Strongly agree
	1	2	3	4	5	6	7
	☐	☐	☐	☐	☐	☐	☐
B12. Overall, I think that for me prescribing a spirometry test to this patient in a context of COPD screening, would be:	Harmfull						Beneficial
	1	2	3	4	5	6	7
	☐	☐	☐	☐	☐	☐	☐

Section C: Interpretation of spirometry testing

Please answer each of the following questions by indicating the number that best corresponds to your opinion regarding the spirometry test prescription. Some questions may seem similar, but they measure different aspects of the stated behavior.

In order to lighten this questionnaire, the masculine will be used in its generic sense.

In a patient of 40 years or older, smoker or ex-smoker, who has no diagnosis of chronic respiratory disease

- who has wheezing during effort or during the night AND/OR
- who expects or spits regularly AND/OR
- who is out of breath, even slightly, when performing simple tasks AND/OR
- who often gets colds that persist longer than people around him AND/OR
- who coughs regularly:

[illegible]

C2. To the best of my knowledge, the proportion of my colleagues who would interpret a spirometry test that would have been prescribed to this patient in a context of COPD screening is:

0-20 %	21-40 %	41-60 %	61-80 %	81-100 %
☐	☐	☐	☐	☐

[illegible][illegible][illegible]

ID Participant : _____

C6. I plan to interpret a spirometry test that would have been prescribed to this patient in a context of COPD screening.	Strongle disagree							Strongly agree
	1	2	3	4	5	6	7	
	☐	☐	☐	☐	☐	☐	☐	
C7. Overall, I think that interpreting a spirometry test that would have been prescribed for this patient in a context of COPD screening would be:	Useless							Usefull
	1	2	3	4	5	6	7	
	☐	☐	☐	☐	☐	☐	☐	
C8. Most people who are important to me in my profession would interpret a spirometry test that would have been prescribed for this patient in a context of COPD screening.	Strongly disagree							Strongly agree
	1	2	3	4	5	6	7	
	☐	☐	☐	☐	☐	☐	☐	
C9. It is acceptable to interpret a spirometry test that would have been prescribed for this patient in a context of COPD screening .	Totally disagree							Totally agree
	1	2	3	4	5	6	7	
	☐	☐	☐	☐	☐	☐	☐	
C10. I am able to interpret a spirometry test that would have been prescribed to this patient in a context of COPD screening.	Strongly disagree							Strongly agree
	1	2	3	4	5	6	7	
	☐	☐	☐	☐	☐	☐	☐	
C11. Overall, I think that for me interpreting a spirometry test that would have been prescribed to this patient in a context of COPD screening, would be:	Harmfull							Beneficial
	1	2	3	4	5	6	7	
	☐	☐	☐	☐	☐	☐	☐	

Summary of CPD-Reaction questionnaire scores on items and constructs for prescription of spirometry.

Construct scale	Items ^a		Responses choices	Pre-coded item value ^b	Final item score ^c	Score by construct ^d
Intention	B1	I intend to prescribe a spirometry test to this patient in a context of COPD screening.	Strongly disagree/agree	1 to 7	1 to 7	(B1+B7)/2
	B7	I plan to prescribe a spirometry test to this patient in a context of COPD screening.	Strongly disagree/agree	1 to 7	1 to 7	
Social influence	B2	To the best of my knowledge, the proportion of my colleagues who would prescribe a spirometry test to this patient in a context of COPD is:	0–20%	1	1.4	(B2+B6+B9)/3
			21–40%	2	2.8	
			41–60%	3	4.2	
			61–80%	4	5.6	
			81–100%	5	7	
	B6	Now think about a co-worker whom you respect as a professional. In your opinion, would he prescribe a spirometry test for this patient in a context of COPD screening?	Never/Always	1 to 7	1 to 7	
	B9	Most people who are important to me in my profession would prescribe a spirometry test to this patient in a context of COPD screening.	Strongly disagree/agree	1 to 7	1 to 7	
Beliefs about capabilities	B3	I am confident that I could prescribe a spirometry test to this patient in a context of COPD if I wanted to.	Strongly disagree/agree	1 to 7	1 to 7	(B3+B5+B11)/3
	B5	For me, prescribing a spirometry test to this patient in a context of COPD screening would be:	Extremely difficult/easy	1 to 7	1 to 7	
	B11	I have the ability to prescribe a spirometry test to this patient in a context of COPD screening.	Strongly disagree/agree	1 to 7	1 to 7	
Moral norm	B4	It is ethical to prescribe a spirometry test to this patient in a context of COPD screening.	Totally disagree/agree	1 to 7	1 to 7	(B4+B10)/2
	B10	It is acceptable to prescribe a spirometry test to this patient in a context of COPD screening.	Totally disagree/agree	1 to 7	1 to 7	
Beliefs about consequences	B8	Overall, I think that for me, prescribing a spirometry test to this patient in a context of COPD screening would be:	Useless/Useful	1 to 7	1 to 7	(B8+B12)/2
	B12	Overall, I think that for me prescribing a spirometry test to this patient in a context of COPD screening, would be:	Harmful/Beneficial	1 to 7	1 to 7	

^a Item number (e.g., B₁ = Item 1 for prescription)

^b Pre-coded item value is a Likert scale assigned value (i.e., Strongly disagree = 1, Strongly agree = 7; Never = 1, Always = 7, etc.)

^c Final item score is the score by item for each participant (possible range scale = 1 to 7)

^d Score by construct = mean score by construct (possible range scale = 1 to 7).

Note: for constructs with two items, no imputed values are possible. For constructs with three items, the raw score of the scale is missing if two or more items are missing. In the case of one missing item, the missing item is imputed from the mean of the two other item.

Summary of CPD-Reaction questionnaire scores on items and constructs for interpretation of spirometry.

Construct scale	Items ^a		Responses choices	Pre-coded item value ^b	Final item score ^c	Score by construct ^d
Intention	C1	I intend to interpret the spirometry test that would have been prescribed for this patient in a context of COPD screening	Strongly disagree/agree	1 to 7	1 to 7	(C1+C6)/2
	C6	I plan to interpret a spirometry test that would have been prescribed to this patient in a context of COPD screening.	Strongly disagree/agree	1 to 7	1 to 7	
Social influence	C2	To the best of my knowledge, the proportion of my colleagues who would interpret a spirometry test that would have been prescribed to this patient in a context of COPD screening is:	0–20%	1	1.4	(C2+C5+C8)/3
			21–40%	2	2.8	
			41–60%	3	4.2	
			61–80%	4	5.6	
			81–100%	5	7	
	C5	Now think about a co-worker whom you respect as a professional. In your opinion, would he be able to interpret a spirometry test that would have been prescribed for this patient in a COPD screening context?	Never/Always	1 to 7	1 to 7	
	C8	Most people who are important to me in my profession would interpret a spirometry test that would have been prescribed for this patient in a context of COPD screening.	Strongly disagree/agree	1 to 7	1 to 7	
Beliefs about capabilities	C3	I am confident that I could interpret a spirometry test that would have been prescribed for this patient in a context of COPD, if I wanted to.	Strongly disagree/agree	1 to 7	1 to 7	(C3+C4+C10)/3
	C4	For me, interpreting a spirometry test that would have been prescribed to this patient in a context of COPD screening would be:	Extremely difficult/easy	1 to 7	1 to 7	
	C10	I am able to interpret a spirometry test that would have been prescribed to this patient in a context of COPD screening.	Strongly disagree/agree	1 to 7	1 to 7	
Moral norm	C9	It is acceptable to interpret a spirometry test that would have been prescribed for this patient in a context of COPD screening.	Totally disagree/agree	1 to 7	1 to 7	C9
Beliefs about consequences	C7	Overall, I think that interpreting a spirometry test that would have been prescribed for this patient in a context of COPD screening would be:	Useless/Useful	1 to 7	1 to 7	(C7+C11)/2
	C11	Overall, I think that for me interpreting a spirometry test that would have been prescribed to this patient in a context of COPD screening, would be:	Harmful/Beneficial	1 to 7	1 to 7	

^a Item number (e.g., C₁ = Item 1 for interpretation)

^b Pre-coded item value is a Likert scale assigned value (i.e., Strongly disagree = 1, Strongly agree = 7; Never = 1, Always = 7, etc.)

^c Final item score is the score by item for each participant (possible range scale = 1 to 7)

^d Score by construct = mean score by construct (possible range scale = 1 to 7).

Note: for constructs with two items, no imputed values are possible. For constructs with three items, the raw score of the scale is missing if two or more items are missing. In the case of one missing item, the missing item is imputed from the mean of the two other item.